From Boson Condensation to Quark Deconfinement: The Many Faces of Neutron Star Interiors

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Gravity compresses the matter in the cores of neutron stars to densities which are significantly higher than the density of ordinary atomic nuclei, thus providing a high-pressure environment in which numerous particle processes – from the generation of new baryonic particles to quark deconfinement to the formation of Boson condensates and H-matter – may compete with each other (cf. Fig. 1). There are theoretical suggestions of even more 'exotic' processes inside pulsars, such as the formation of absolutely stable strange quark matter, a configuration of matter even more stable than the most stable atomic nucleus, iron. In the latter event, neutron stars would be largely composed of pure quark matter, eventually enveloped in nuclear crust matter. No matter which physical processes are actually realized inside neutron stars, each one leads to fingerprints, some more pronounced than others though, in the observable stellar quantities. This feature combined with the tremendous recent progress in observational radio and X-ray astronomy, renders neutron stars to nearly ideal probes for a wide range of dense matter studies, complementing the quest of the behavior of superdense matter in terrestrial collider experiments [1].

This paper [1] gives an overview of the present status of the research on the many phases of superdense matter in neutron stars, which naturally is to be performed at the interface between nuclear physics, particle physics and Einstein's theory of relativity. Of particular interest will be the existence of quark matter inside neutron stars and the fingerprints by means of which this novel phase of matter could register itself in the observed neutron star data.

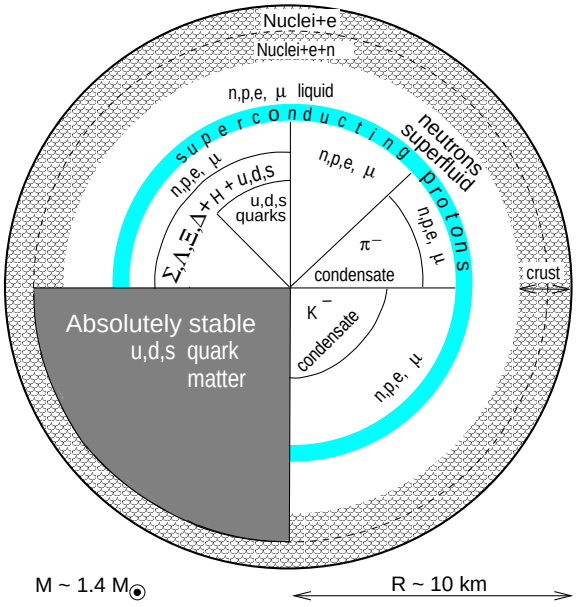

Figure 1: Phases of high-density matter predicted by theory to make their appearances in the cores ($R \lesssim 8$ km) of neutron stars.

References

[1] F. Weber; Acta Physica Polonica B30 (1999) 3149.